Far-infrared BIB detectors for CLARREO

Henry Hogue[1], Martin Mlynczak[2], and Mark Muzilla[1]

[1]DRS Sensors and Targeting Systems, Cypress, CA
[2]NASA Langley Research Center, Hampton, VA

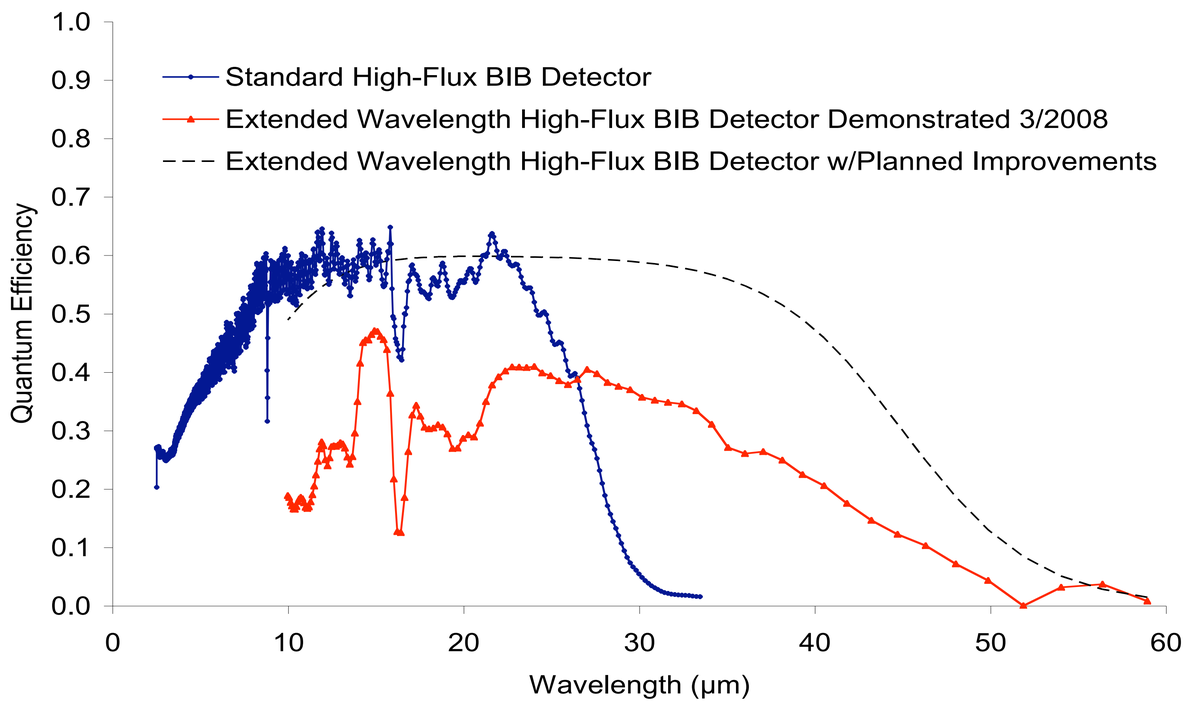
ABSTRACT

DRS Sensors & Targeting Systems NASA Langley Research Center Earth Science Directorate have demonstrated far-infrared Blocked Impurity Band (BIB) detectors suitable for CLARREO application. Wavelength range is extended to ~50 μm, in initial devices, almost 2 times the usual cut-off for arsenic-doped-silicon Blocked Impurity Band (BIB) detectors. The new far-IR member of the BIB detector family operates at temperatures accessible to existing space-qualified cryocoolers, while retaining the very high values of sensitivity, stability, linearity, and bandwidth typical of the broader class of silicon BIB detectors. Proposed further development of this detector technology includes wavelength extension to a goal of at least 100 μm, improvements in detector design, and implementation of light-trapping packaging. These are developments that will enable increased radiometric accuracy, reduced spatial smearing, and simpler calibration approaches for CLARREO.

OBJECTIVE

Provide detectors suitable for Fourier Transform Spectrometer instrumentation for important CLARREO far-infrared Earth radiance measurements from orbit

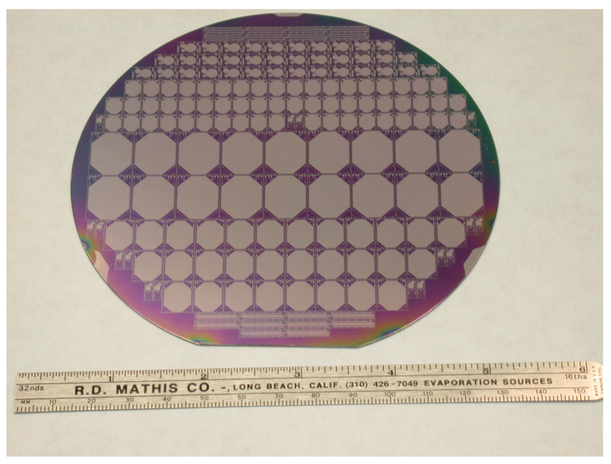
- Spectral response to at least 50 μm (goal 100 μm)
- Operation with existing space cryocoolers (>10 K)
- High sensitivity (D* > 10^{10} Jones) and
- Fast response (B/W > 100 kHz) for high resolution
- Very stable and linear (<0.1% nonlinearity)
- Short development path to high TRL
- Measurement errors due to environment or instrument induced QE changes attenuated by 100X



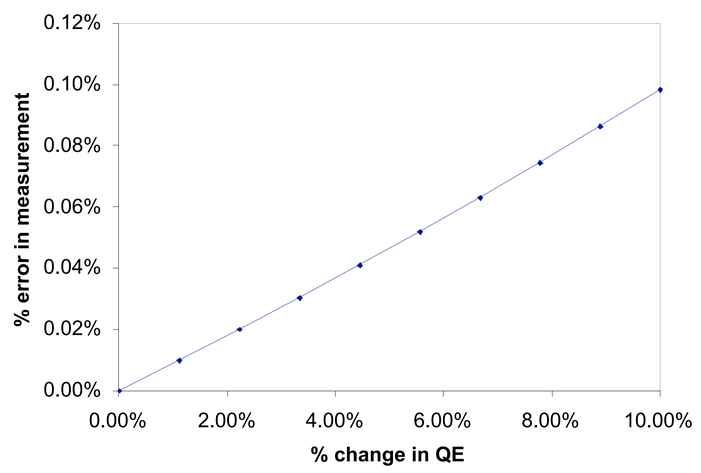
Demonstrated spectral performance (no AR Coating)

APPROACH

Adapt Blocked Impurity Band detectors, which have extensive heritage for mid-infrared measurements from space, to far-infrared infrared wavelengths. A two detector light-trapping approach has been defined to avoid reflection losses, to provide a FTS detector that detects 99.9% of incident photons, and is thus has a high degree of calibration stability. The light-trapping detector design will be adapted from that developed by the National Institute for Standards and Technology being considered for their next generation transfer radiometer.



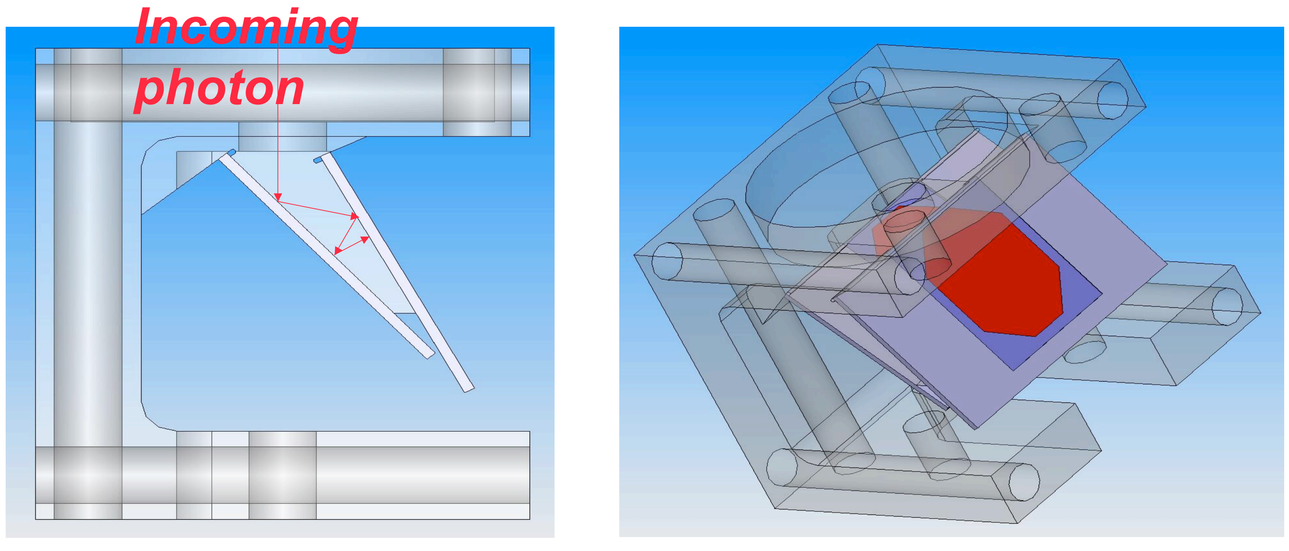
125-mm detector wafer



Measurement Errors from QE changes attenuated 100X

RESULTS

Achieved spectral response to > 50 μm (red curve), almost 2X conventional Si:As BIB detector (blue curve, no AR coating). Design for fully depleted device (dashed line) will allow performance comparable to conventional Si:As BIB detector. Further, an approach developed for NIST transfer radiometers can nearly eliminate all absorption losses and achieve QE of 70% non-coated (99.5% internal QE).



Proposed light-trapping geometry (NIST design)